

Appl. No. : 10/698,878
Filed : October 31, 2003

AMENDMENTS TO THE DRAWINGS

Please replace Figures 1-5 and 9C with new Figures 1-5 and 9C. Replacement drawing sheets for Figures 1-5 and 9C are enclosed with this Amendment.

REMARKS

Reconsideration and allowance of this application, as amended, is respectfully requested. Figure 1-5 and 9C of this application have been replaced with new Figures 1-5 and 9C. Claims 1-13 were pending in this application prior to entry of the above-mentioned amendments. Claims 1, 2, 7, 8 and 9 have been amended. No new matter is added by these amendments.

Applicants submit that this application, as amended, is in condition for allowance and such action is earnestly requested. Each of the Examiner's reasons for rejection is addressed below.

Drawings

The drawings were objected to because Figures 1-5 did not include "Prior Art" designations. Accordingly, Applicants have replaced Figures 1-5 with new Figures 1-5 to include this designation.

Figure 9C was objected to because " I_2 " was erroneously labeled " I_3 ." Applicants have replaced Figure 9C with new Figure 9C to correct this error.

Amendments to the claims

Claims 1 and 9 have been amended to clarify the invention. Claim 1, as amended, recites, *inter alia*, "determining a transition current density that is capable of filling the cavity with the conductive material forming a substantially flat profile over an opening of the cavity...applying an initial process current density as the workpiece surface enters the process solution to partially fill the cavity with the conductive material, wherein the initial current density is lower than the transition current density; applying a first process current density to fill a remainder of the cavity with the conductive material and form a substantially flat profile over the opening of the cavity, wherein the first process current density is substantially the same as the transition current density; and applying a second process current density to form a substantially flat conductive layer over the cavity, wherein the second process current density is higher than the transition current density." Claim 9, as amended, recites, *inter alia*, "determining a transition current density that is capable of filling the cavity with the conductive material forming a substantially flat profile over an opening of the cavity; and performing an electrodeposition process on a plurality of workpieces by depositing the conductive material onto the surface of the workpieces using a

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variable current density including an initial process current density to partially fill the cavity, a first process current density to substantially fill a remainder of the cavity and form a substantially flat profile over the opening of the cavity, and a second process current density to form the flat conductive layer over the cavity, wherein the first process current density is substantially the same as the transition current density, and the second process current density is higher than the transition current density.” No new matter is added by any of these amendments. Support for these amendments can be found in the application as originally filed (“the Application”), U.S. Patent Publication No. 2005/0095854, at, for example, paragraphs [0043] and [0052], and Fig. 13 of the publication.

Claims 2 and 8 have been amended for consistency with amended Claim 1.

Claim 7 has been amended to correct a typographical error.

Section 102 rejections

Claims 1-2 and 8-10 stand rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent no. 6,432,821 to Dubin et al. (“Dubin”), and Claims 1-3, 9-10 and 13 stand rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent Publication No. 2001/0015321 to Reid et al. (“Reid”). The Examiner has found that Dubin and Reid teach applying an initial process current density as the workpiece surface enters the process solution, applying a first process current density to fill the cavity with conductive material, and applying a second process current density to form a substantially flat conductive layer. Additionally, the Examiner has found that “with respect to the first, second and third transition current density, these current densities are arbitrary predetermined values to provide void-free conformal plating.” The Examiner asserts that because the current densities of Dubin and Reid “provide void-free conformal plating,” any current density within the ranges of Dubin and Reid “can be arbitrarily selected to serve as the first, second, or third transition current density, while maintaining their magnitude relationship.” Office Action at pages 3-5.

Without acquiescing in these findings, Applicants have amended the claims to clarify the invention. Each step in the recited processes is clearly associated with a corresponding status of the deposition, in addition to relative current density magnitude.

While Dubin teaches application of a forward current 702 to form an initial seed layer on surface features followed by application of forward currents 704, 706 to fill the smallest

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damascene features (*see* Dubin, Fig. 7, and col. 5, lines 11-18), Dubin does not determine a transition current density capable of filling surface features and forming a substantially flat profile over the features, let alone performing the recited sequence of current densities in relation to the transition current density to form a flat profile over the surface features. Furthermore, Dubin does not teach or disclose forming a substantially flat profile over the openings of its smallest damascene features via application of forward current 704, which the Examiner has associated with “applying a first process current density,” as recited in original Claim 1, and performing an electrodeposition process using a variable current density, including a first process current density, as recited in original Claim 9. Similarly, while Reid teaches an initiation phase to deposit a seed layer, a bottom-up filling phase to fill trenches and vias, and a low aspect ratio filling phase to fill larger surface features (*see* Reid, paragraphs [0023]-[0030]), Reid does not determine a transition current density that is capable of filling trenches or vias and forming a substantially flat profile over the trenches or vias, let alone selecting current densities in relation to the transition current density in each of the deposition phases. Additionally, while Reid teaches use of levelers (DTAB) to reduce the height of protrusions over trenches to “less than a third of the height of the protrusions” obtained when no leveler is present (*see* paragraph [0027] of Reid), Reid does not teach or disclose forming a substantially flat profile over the openings of the trenches, contrary to the amended claims. Consequently, as neither Dubin nor Reid meets the language of amended Claims 1 and 9, Applicants respectfully request that the §102(b) rejections of Claims 1 and 9 be withdrawn.

Claims 2, 3, 8 and 10-13 recite additional distinguishing features with particular advantages. Moreover, these claims are allowable because they depend from and therefore include all of the limitations of amended Claims 1 and 9. Neither Dubin nor Reid teaches all of the limitations of amended Claims 1 and 9, let alone the unique combinations of limitations of Claims 2, 3, 8 and 10-13. Accordingly, Applicants respectfully request that the §102(b) rejections of Claims 2, 3, 8 and 10-13 also be withdrawn.

Section 103 rejections

Claims 3-7 and 11-13 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Dubin. Claims 4-8 and 11-12 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Reid.

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Without acquiescing in the Examiner's reasons for rejection, Applicants submit that Claims 3-8 and 11-13 are allowable because they depend from and therefore include all of the limitations of Claims 1 and 9, in addition to reciting further distinguishing features of particular utility. In view of the asserted allowability of Claims 1 and 9 (see above), Applicants respectfully request that the §103(a) rejections of Claims 3-8 and 11-13 be withdrawn.

CONCLUSION

In view of the foregoing amendments and remarks, Applicants respectfully submit that this application is in condition for allowance and request the same. If there is any further hindrance to allowance of the pending claims, the Examiner is invited to contact the undersigned.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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